UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Utilities Service

BULLETIN 1755F-402 (PE-52)

SUBJECT: **RUS Specification for Telecommunications Splicing Connectors**

TO: All Telecommunications Borrowers
RUS Telecommunications Staff

EFFECTIVE DATE: [INSERT EFFECTIVE DATE OF FINAL RULE]

OFFICE OF PRIMARY INTEREST: Outside Plant Branch, Telecommunications Standards Division, Telecommunications Program.

FILING INSTRUCTION: This bulletin supersedes REA Bulletin 345-54, "REA Specification for Telephone Splicing Connectors," PE-52, dated December 3, 1971 (revised pages dated 8/07/1972).

AVAILABILITY: This bulletin can be accessed via the Internet at http://www.usda.gov/rus/telecom/publications/bulletins.htm.

PURPOSE: This specification covers the requirements for mechanical splicing connectors used for joining insulated copper conductors and optical fibers of aerial, buried, and underground type cables and wires conforming to RUS cable and wire specifications.

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Date

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ABBREVIATIONS

ac	Alternating Current
ASTM	American Society For Testing And Materials
AWG	American Wire Gauge
°C	Degrees of Temperature, Celsius Scale
°	Degrees
dc	Direct Current
EIA	Electronics Industries Association
°F	Degrees of Temperature, Fahrenheit Scale
in.	Inch or Inches
IR	Insulation Resistance
mm	Millimeters
%	Percent
RH	Relative Humidity
rms	Root-Mean-Squared
RUS	Rural Utilities Service
s	Seconds
TIA	Telecommunications Industries Association

1 SCOPE

a The purpose of this specification is to inform manufacturers and users of copper splicing connectors and mechanical fiber optic splicing connectors of the engineering and technical requirements that are considered necessary for satisfactory performance in rural outside plant environments. Included are the relevant electrical, mechanical, optical, environmental requirements, desired design features, and test methods for evaluation of copper cable splicing connectors and fiber optic splicing connectors.

b All copper and fiber optic cable splicing connectors sold to Rural Utilities Service (RUS) borrowers for projects involving RUS loan funds under this specification shall be accepted by RUS Technical Standards Committee “A” (Telecommunications). For connectors manufactured to this specification, all design changes to an accepted design shall be submitted for acceptance. RUS shall be the sole authority on what constitutes a design change.

c Copies of American Society for Testing and Materials Specifications (ASTM) A 276-04, “Standard Specification for Stainless Steel Bars and Shapes”; ASTM D 4566-98, “Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable”; ASTM G 21-96(02), “Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi”, as referenced in this specification, can be obtained from ASTM for a nominal fee at the address indicated below:

ASTM
100 Barr Harbor Drive
West Conshohocken, Pennsylvania 19428-2959
Telephone: (610) 832-9585

d Copies of Electronics Industries Association/Telecommunications Industries Association (EIA/TIA)-455-12A, “Fluid Immersion Test for Fiber Optic Components” as referenced in this specification, can be obtained from Global Engineering Documents for a nominal fee at the address indicated below:

Global Engineering Documents
15 Inverness Way East
Englewood, Colorado 80112
Telephone: (303) 792-2181

e Copies of Telecommunications Industries Association/Electronics Industries Association (TIA/EIA)-455-3A, “Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components”; TIA/EIA-455-4C, “Fiber Optic Component Temperature Life Test”; TIA/EIA-455-5C, “Humidity Test Procedure for Fiber Optic Components”; TIA/EIA-455-11C, “Vibration Test Procedure for Fiber Optic Components and

Cables"; TIA/EIA-455-34A, "Interconnection Device Insertion Loss Test"; and TIA/EIA-455-171A, "Attenuation by Substitution Measurement For Short-Length Multimode Graded-Index and Single-Mode Optical Fiber Cable Assemblies" as referenced in this specification, can be obtained from Global Engineering Documents for a nominal fee at the address indicated below:

Global Engineering Documents
15 Inverness Way East
Englewood, Colorado 80112
Telephone: (303) 792-2181

f Copies of Telecommunications Industries Association (TIA)-455-6B, "Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices"; TIA-455-21A, "Mating Durability of Fiber Optic Interconnecting Devices"; and TIA-455-107A, "Determination of Components Reflectance of Links/Systems Return Loss Using a Loss Test Set" as referenced in this specification, can be obtained from Global Engineering Documents for a nominal fee at the address indicated below:

Global Engineering Documents
15 Inverness Way East
Englewood, Colorado 80112
Telephone: (303) 792-2181

2 MATERIALS

a The plastic components used in the splicing connectors shall be resistant to chemical attack, fungus growth, and growth of contaminating films as specified in ASTM G 21-96(02). Metallic materials used in the splicing connectors shall have a corrosion equivalent to nickel-chrome stainless steel in accordance with ASTM A 276-04.

b All splicing connector shall be filled with an encapsulating grease or gel which prevents connection degradation caused by moisture and corrosion.

c The manufacturer shall demonstrate the existence of an ongoing quality assurance program that includes controls, procedures, and standards used for vendor certification, source inspection, incoming inspection, manufacture, in process testing, calibration and maintenance of tools and test equipment, final product inspection and testing, periodic qualification testing and control of nonconforming materials and products. The manufacturer shall maintain quality assurance records for five (5) years.

3 PERFORMANCE CRITERIA AND TEST PROCEDURES FOR COPPER SPLICING CONNECTORS

a General Information:

(1) Copper cable splicing connectors have the function of splicing one (1) or more combinations of Number (No.) 19 through No. 26 American Wire Gauge (AWG) copper conductors.

(2) The manufacturer shall specify the wire gauge range for the connector or connectors submitted to RUS for acceptance.

(3) The manufacturer shall specify the splicing configuration for the connector, i.e., inline, butt, tap, or other.

(4) The manufacturer shall perform adequate inspections and tests to demonstrate that copper cable splicing connectors and their components comply with RUS requirements.

(5) Unless otherwise specified, all tests shall be performed at a temperature of 24 ± 3°C (75 ± 5°F) and a relative humidity (RH) of up to 55 percent (%). All cables used for the testing shall be RUS accepted. Stripping of the conductor insulation for the tests shall not be permitted.

b Test Samples:

(1) Unless otherwise specified, all test samples shall be assembled for each connector type as follows:

(a) The largest specified gauge wire connected with the largest specified gauge wire;

(b) The smallest specified gauge wire connected with the smallest specified gauge wire; and

(c) The smallest specified gauge wire connected with the largest specified gauge wire. For connectors which can connect more than two (2) wires, assemble the greatest number of the smallest gauge wire connected with one (1) of the largest gauge wires.

(2) For each test required, five (5) samples from each of the categories in paragraph b(1) of this section shall be tested. A total of fifteen (15) samples will be needed for each test.

(3) The test results for each sample shall be submitted in a tabulated form.

c Connection Resistance Test:

(1) Thirty (30) 4 inch (in.)[102 millimeter (mm)] pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph b(1) of this section using the connector manufacturer's instructions. For resistance measurements, expose the copper conductors of the test leads by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of insulation from the end of the test leads.

(2) Fifteen (15) 8 in. (203 mm) pieces of wire shall be cut from the appropriate gauged wire for use as control wire samples. For resistance measurements, expose the copper conductors of the control wire samples by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of insulation from both ends of the control wire samples.

(3) The initial resistance of each test sample shall be measured and recorded. The initial resistance of a corresponding control wire sample shall be measured and recorded. The initial resistance of each test sample shall not exceed the initial resistance of the corresponding control wire sample by more than 7%.

(4) After measuring the initial resistance, each test sample shall be secured and each connector shall be twisted 90º around the wire axis once in each direction. After twisting, the resistance of the test sample shall be measured and recorded. The resistance of each test sample shall not exceed the initial resistance of the corresponding control wire sample by more than 9%..

d Temperature Cycling Test:

(1) After completion of the connection resistance test, the test samples shall be subjected to the temperature cycling test.

(2) The test samples shall be placed in an environmental test chamber and exposed to the temperature cycle of Figure 1 of this specification for five (5) complete cycles. The step function nature of the temperature changes may be achieved by insertion and removal of the test samples from the test chamber. The soak time at each temperature shall not be less than four (4) hours. The test samples shall be removed from the test chamber at the conclusion of the five-cycle period and shall be allowed to return to room temperature.

(3) No resistance measurements on the test samples shall be made after completion of the temperature cycling test.

e Vibration Test:

(1) After completion of the temperature cycling test, the test samples shall be subjected to the vibration test.

(2) A vibration machine shall be used which produces a simple harmonic motion having 0.06 in. (1.52 mm) maximum total excursion, cycling from 10 to 55 to 10 Hertz within one (1) minute. A monitoring circuit shall be used which is capable of detecting momentary opens of 10 microseconds or longer.

(3) Each test sample shall be supported by a pegboard as indicated in Figure 2 of this specification, which is attached to the vibration machine. Wire shall not be cut short.

(4) The test samples shall be vibrated for a total of three (3) hours, one (1) hour in each of the three (3) mutually exclusive planes as indicated in Figure 3 of this specification. The direct current (dc) through the test samples shall be monitored for any fluctuations or momentary opens. Fluctuations or momentary opens shall be less than or equal to 10 microseconds.

(5) After completion of the vibration test, the test samples shall be removed from the vibration machine and the connection resistance of each test sample shall be measured and recorded. The resistance of each test sample shall not exceed the initial resistance of the corresponding control wire sample by more than 13%.

(6) The test samples shall be discarded after completion of the vibration test.

f Insulation Resistance (IR) – Humidity Cycle:

(1) Thirty (30) 15 in. (381 mm) pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph b(1) of this section using the connector manufacturer's instructions. For IR measurements, expose the copper conductors of the test sample leads by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of the insulation from the ends of the test sample leads. The exposed copper conductors of the test sample leads shall be twisted together as indicated in Figure 4 of this specification.

(2) The test samples shall be placed in an environmental test chamber at 95 ± 3% RH and temperature cycled in accordance with Figure 5 of this specification for a period of thirty (30) days.

(3) After the thirty (30) day period, remove the test samples from the environmental test chamber and allow the test samples to stabilize at room

temperature and humidity. After the test samples have been allowed to stabilize at room temperature and humidity, measure the IR of the test sample leads to ground in accordance with ASTM D 4566-98 using a test voltage of not less than 250 volts dc. The IR of the test sample leads to ground shall be greater than or equal to 100,000 megohms.

(4) The test samples shall be discarded after completion of the IR – humidity cycle test.

g Insulation Resistance (IR) – Water Soak:

(1) Thirty (30) 15 in. (381 mm) pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph b(1) of this section using the connector manufacturer's instructions. For IR measurements, expose the copper conductors of the test sample leads by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of the insulation from the ends of the test sample leads. The exposed copper conductors of the test sample leads shall be twisted together as indicated in Figure 4 of this specification.

(2) A solution of distilled or tap water and sodium chloride (5% by weight) shall be prepared and placed in a glass container.

(3) The connectors of the test samples shall be immersed in the solution except for the twisted test leads of the test samples. A copper electrode shall be inserted into the solution.

(4) After the system (immersed connectors and solution) has stabilized for two (2) hours, the first IR measurements of the test sample leads to the copper electrode shall be taken and recorded. The IR test shall be performed in accordance with ASTM D 4566-98 using a test voltage of 100 volts dc.

(5) The test samples shall be removed from the solution after seventy-two (72) hours and allowed to stabilize at room temperature and humidity for an additional seventy-two (72) hours. This procedure shall be repeated for a total of five (5) cycles. The IR measurements of the test sample leads to the copper electrode shall be taken and recorded for each day that the test samples are immersed in the solution. IR readings shall be reported in megohms. Te IR test shall be performed in accordance with ASTM D 4566-98 using a test voltage of 100 volts dc.

(6) The IR of the test sample leads to the copper electrode shall be greater than or equal to 100 megohms.

(7) The test samples shall be discarded after completion of the IR – water soak test.

h Dielectric Breakdown (Dry):

(1) Thirty (30) 15 in. (381 mm) pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph b(1) of this section using the connector manufacturer's instructions. For dielectric breakdown measurements, expose the copper conductors of the test sample leads by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of the insulation from the ends of the test sample leads. The exposed copper conductors of the test sample leads shall be twisted together as indicated in Figure 4 of this specification.

(2) An alternating current (ac) power source capable of applying 8,000 volts in 500 volt root-mean-squared per second (rms/s) steps shall be used for the testing. The unit shall be equipped with a circuit breaker to disconnect the power source at breakdown and a voltmeter to indicate the rms voltages.

(3) The high voltage lead of the power source shall be attached to the test sample lead and the ground voltage lead of the power source shall be attached to ground. The voltage shall be applied to the test sample in 500 volt rms/s steps until either breakdown or 8,000 volts rms maximum voltage is reached. The dielectric strength shall be recorded in rms voltage at the point of breakdown. Breakdown occurring at less than 2,500 volts rms shall constitute a failure.

(4) The dielectric breakdown test shall be repeated for all the remaining test samples prepared in accordance with paragraph h(1) of this section. The test results shall be reported for each test sample.

(5) The test samples shall be discarded after completion of the dry dielectric breakdown test.

i Dielectric Breakdown (Wet):

(1) Thirty (30) 15 in. (381 mm) pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph b(1) of this section using the connector manufacturer's instructions. For dielectric breakdown measurements, expose the copper conductors of the test sample leads by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of the insulation from the ends of the test sample leads. The exposed copper conductors of the test sample leads shall be twisted together as indicated in Figure 4 of this specification.

(2) An ac power source capable of applying 8,000 volts in 500 rms/s steps shall be used for the testing. The unit shall be equipped with a circuit breaker to disconnect the power source at breakdown and a voltmeter to indicate the rms voltages.

(3) A solution of distilled or tap water and sodium chloride (5% by weight) shall be prepared and placed in a glass container.

(4) The connectors of the test samples shall be immersed in the solution except for the twisted test leads of the test samples. A copper electrode shall be inserted into the solution.

(5) The high voltage lead of the power source shall be attached to the test sample lead and the ground voltage lead of the power source shall be attached to ground. The voltage shall be applied to the test sample in 500 volt rms/s steps until either breakdown or 8,000 volts rms maximum voltage is reached. The dielectric strength shall be recorded in rms voltage at the point of breakdown. Breakdown occurring at less than 2,500 volts rms shall constitute a failure.

(6) The dielectric breakdown test shall be repeated for all the remaining test samples prepared in accordance with paragraph i(1) of this section. The test results shall be reported for each test sample.

(7) The test samples shall be discarded after completion of the wet dielectric breakdown test.

j <u>Current Cycling</u>:

(1) Twenty (20) 4 in. (102 mm) pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph b of this section using the connector manufacturer’s instructions. For the current cycling test, the five (5) test samples prepared in accordance with paragraph b(1)(a) specified in paragraph b(1) of this section and five (5) test samples prepared in accordance with paragraph b(1)(b) specified in paragraph (b)1 of this section for a total of ten (10) test samples shall be used for the testing. For the current cycling test, expose the copper conductors of the test sample leads by removing 0.5 in. to 1.0 in. (12 mm to 25 mm) of the insulation from the ends of the test sample leads.

(2) A rack with mounting lugs spaced 5.0 in. (127 mm) apart shall be used for the test. The test sample leads for the five (5) test samples prepared in accordance with Item a. of paragraph b(1) of this section shall be carefully bent and straightened so that the test samples lie approximately midway between the mounting lugs. The test leads between the mounting lugs

shall be under no tension. The ends of the test leads shall be soldered to the mounting lugs. The test setup shall be as shown in Figure 6 of this specification.

(3) The five (5) test samples prepared in accordance with paragraph b(1)(a) of this section shall be connected in series with an ammeter and a power source. The power source shall be adjusted to the “Initial” current specified in Table 1 of this section. The voltage drop across each test sample at the mounting lugs shall be measured and recorded. The power source shall then be adjusted to the “Test” current specified in Table 1 of this section. The “Test” current shall be applied to the test samples for forty-five (45) minutes and then off for fifteen (15) minutes. The application of the “Test” current for a period of forty-five (45) minutes on and a period of fifteen (15) minutes off shall constitute one (1) cycle. A total of fifty (50) cycles shall be applied to the test samples.

Table 1
Test Currents

Wire Size (AWG)	“Initial” & “Final” Current (Amperes)	Test Current (Amperes)
19	11	14
22	9	11
24	4.5	5.6
26	3	3.8

(4) At the completion of the fifty (50) cycles, current on the test samples shall be reduced to the “Final” current specified in Table 1 of this section. The voltage drop across each test sample at the mounting lugs shall be measured and recorded. The “Final” voltage drop measurement shall be compared with the “Initial” voltage drop measurement recorded in paragraph j(3) of this section. An increase in the voltage drop of more than 5% for each test sample shall constitute a failure.

(5) The five (5) test samples prepared in accordance with paragraph b(1)(b) of this section shall be tested in accordance with the procedures specified in paragraphs j(3) and j(4) of this section. The connectors shall be tested using the appropriate current for the specific wire size indicated in Table 1 of this section.

k Tensile Test:

(1) Thirty (30) 10 in. (254 mm) pieces of wire shall be cut from the appropriate gauged wire and assembled in the connectors in accordance with paragraph 3b of this section using the connector manufacturer's instructions.

(2) Three (3) samples of each control wire gauge size shall be tested using a tensile machine with a jaw separation speed if 2 in. (51 mm) per minute, to determine the average breaking strength of each control wire gauge size. The average breaking strength of each control wire gauge size shall be recorded.

(3) Each test sample assembled in accordance with paragraph 3k(1) of this section shall be tested for either "Pull-out" or "Break" using a tensile machine with a jaw separation speed of 2 in.(51 mm) per minute. The test setup for the "Pull-out" or "Break" test shall be in accordance with Figure 7 of this specification. The "Pull-out" or "Break" of each test sample shall not less than 60% of the average breaking strength of each control wire size recorded in paragraph 3k(2) of this section. For the five (5) test samples that include the smallest and largest gauge wire sizes, the "Pull-out" or "Break" measurement shall be compared to the average breaking strength of the smallest control wire gauge size recorded in paragraph 3k(2) of this section.

4 PERFORMANCE CRITERIA AND TEST PROCEDURES FOR MECHANICAL FIBER OPTIC SPLICES

a Mechanical fiber optic splices shall be classified according to their functions listed below:

(1) Passive splicing – mechanically joining two fibers;

(2) Tunable splicing – mechanically joining two fibers using an active loss measuring system for adjusting splice elements for the lowest loss during assembly; or

(3) Mass splicing – mechanically joining multiple fibers simultaneously.

b A mechanical fiber optic splice shall be constructed that when assembled the splice shall have a resistance to optical decoupling. The mechanical splice assembly shall not optically decouple at less than a specified value of axial tension.

c Optical requirements for multimode and single mode optical splices shall be in accordance with Table 2 of this section. The test methods used to determine insertion and return loss shall be in accordance with TIA/EIA-455-34A, TIA/EIA-455-171A, or TIA-455-107A.

Table 2

Optical Requirements – Mechanical Fiber Optic Splices

	Single Mode		Multimode
Splice Type	Insertion Loss [Decibels (dB)]	Return Loss (dB)	Insertion Loss (dB)
Passive	0.20	-35	0.15
Tunable	0.05	-35	0.15
Mass*	0.50	-35	0.15

*Loss results for mass splicing techniques shall be the averaged.

d Mechanical fiber optic splices shall be capable of resisting mechanical stresses associated with installation and service without impairment of the splice integrity.

e Single mode and multimode mechanical fiber optic splices shall be tested for mechanical reliability in accordance with the test methods specified in Table 3 of this section. After each mechanical test, the single mode and multimode mechanical fiber optic splices shall be in accordance with the requirements specified in paragraph 4c, Table 2.

Table 3

Mechanical Tests – Mechanical Fiber Optic Splices

Test	Procedure	Requirement
Re-Coupling Durability (if appropriate)	TIA-455-21A	25 Cycles
Fiber Retention	TIA-455-6B	0.45 Kilogram Force (1.0 Pound Force)
Vibration	TIA/EIA-455-11C	10 – 55 Hertz. 10 Grams (0.35 pounds)

f Single mode and multimode mechanical fiber optic splices shall be tested for environmental reliability in accordance with the methods specified in Table 4 of this section. After each environmental test, the single mode and multimode mechanical fiber optic splices shall be in accordance with the requirements specified in paragraph 4c, Table 2.

Table 4
Environmental Tests – Mechanical Fiber Optic Splices

Test	Procedure	Requirement
Humidity	TIA/EIA-455-5C	> 90% Relative Humidity, 40°C, 240 Hours
Thermal Cycling	TIA/EIA-455-3A	-40°C to 80°C, 100 Cycles
Water Immersion	EIA/TIA-455-12A	40°C, 240 Hours
Material Aging	TIA/EIA-455-4C	84°C, 2000 Hours

5 PACKAGING, IDENTIFICATION, AND DOCUMENTATION

a The packaging shall include identification of the manufacturer, splice model number, and date of manufacture. All necessary components shall be shipped in one (1) container unless significant advantages to the user will result otherwise.

b Complete documentation shall be included with the packaging to provide the following information:

(1) Use and application;

(2) Set-up and assembly;

(3) Testing and repair;

(4) Field installation;

(5) Auxiliary equipment, and

(6) Storage instructions.

6 RUS ACCEPTANCE PROCEDURE

a The tests described in this specification are required for acceptance of product designs and major modifications of accepted designs. All modifications shall be considered major unless otherwise declared by RUS. These tests are intended to demonstrate the capability of the manufacturer to produce splice components which meet the service requirements of RUS telecommunications borrowers.

b For initial acceptance the manufacturer shall:

(1) Certify that the product fully complies with each paragraph of the specification, and submit supporting test data;

(2) Submit catalog numbers for the splice;

(3) Submit quality assurance data which is representative of at least three (3) production lots and which demonstrate-- the reliability of an ongoing quality assurance program;

(4) Certify whether the product complies with the domestic origin manufacturing provisions of the “Buy American” Requirement of the Rural Electrification Act of 1938 (7 U.S.C. 903 note), as amended (the REA Buy American Provision);

(5) Submit at least three (3) written user testimonials concerning field performance of the product;

(6) Submit descriptive information concerning the splice;

(7) Submit assembly and usage instructions for the splice;

(8) Submit product identification information; and

(9) Submit information concerning the packaging and shipment of the splice to customers.

c For requalification acceptance, the manufacturer shall:

(1) Submit a letter certifying that no modifications have made to the accepted design. If design modifications were made and RUS accepted, the letter shall contain a list of modifications and the dates the modifications were accepted by RUS; and

(2) Certify whether the product does or does not comply with the domestic origin manufacturing provisions of the “Buy American” Requirement of the Rural Electrification Act of 1938 (7 U.S.C. 903 note), as amended (the REA Buy American Provision).

d The required certifications specified in Items a. and b. of paragraph 6c of this section shall be submitted to RUS by no later than June 30 every three (3) years.

e Initial and requalification acceptance requests shall be addressed to Chairman, Technical Standards Committee “A” (Telecommunications), Telecommunications Standards Division, Rural Utilities Service, U.S. Department of Agriculture, 1400 Independence Avenue, SW., STOP 1598, Washington, DC 20250-1598.

FIGURE 1
TEST TEMPERATURE CYCLE – TEMPERATURE CYCLING TEST

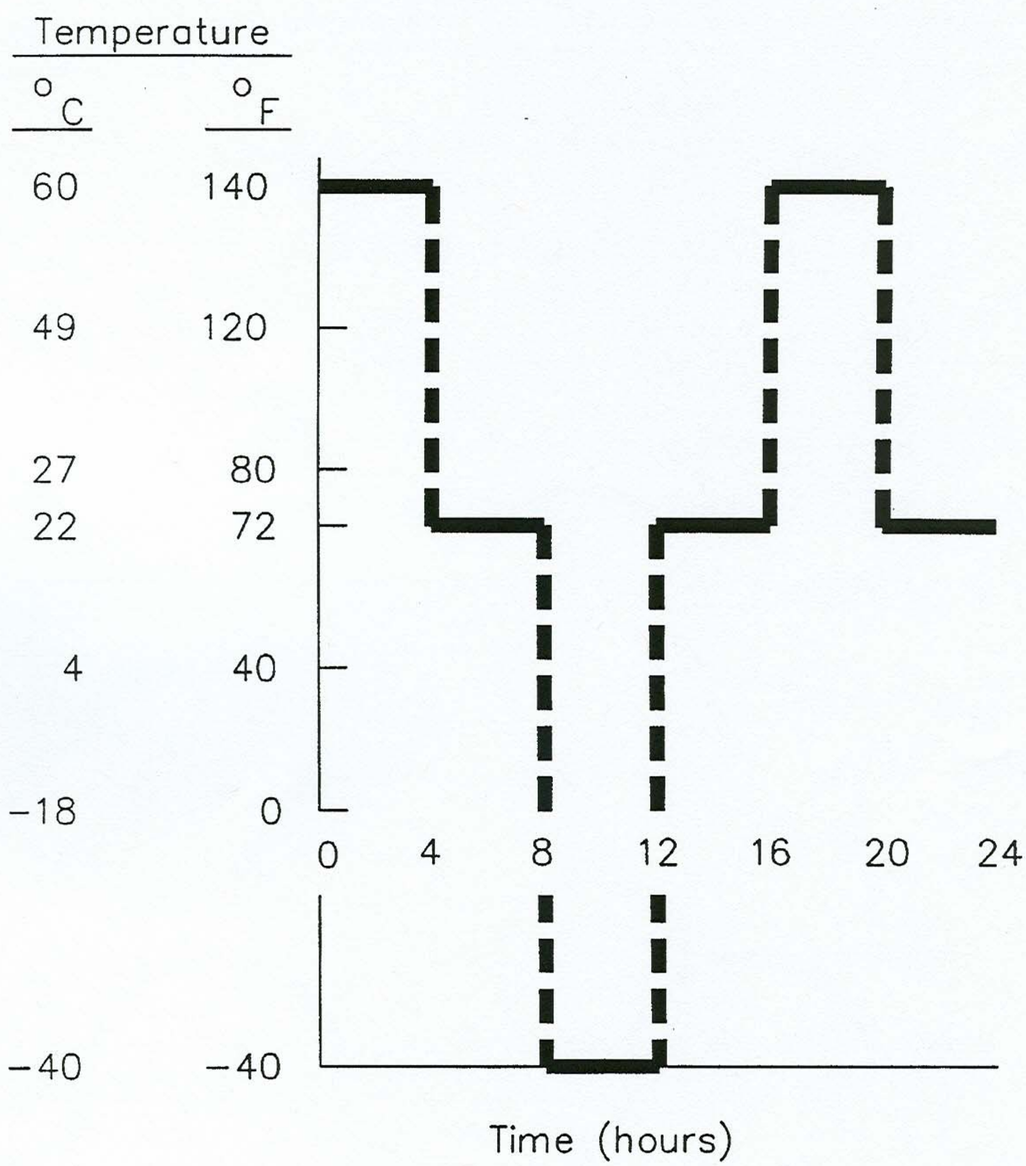


FIGURE 2
TEST SAMPLE SUPPORT – VIBRATION TEST

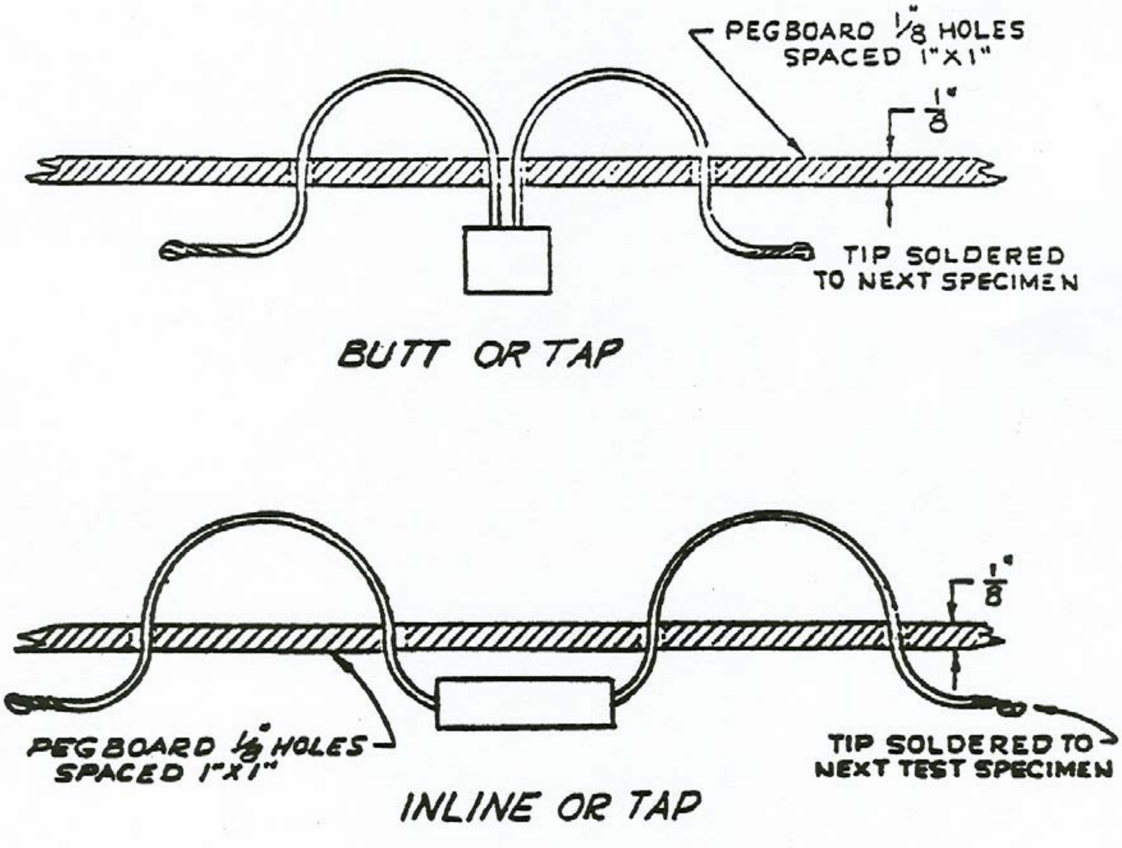


FIGURE 3
VIBRATION TEST PLANES

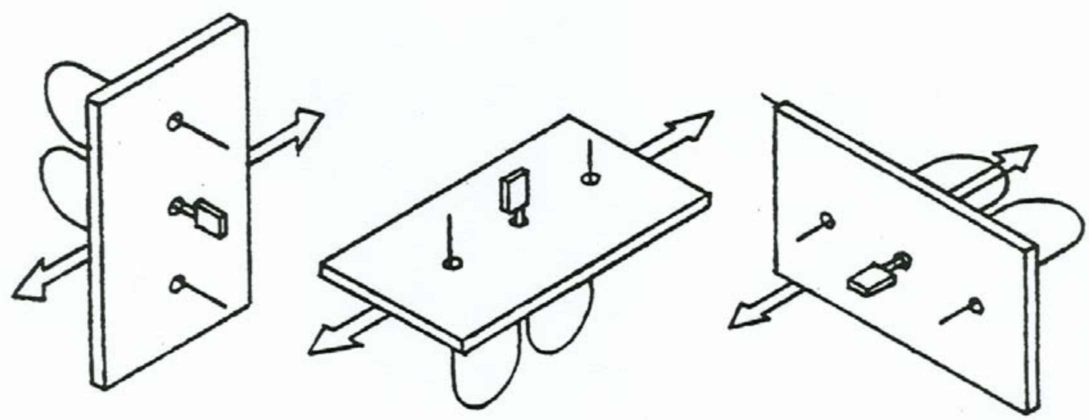


FIGURE 4
TWISTING OF TEST LEADS

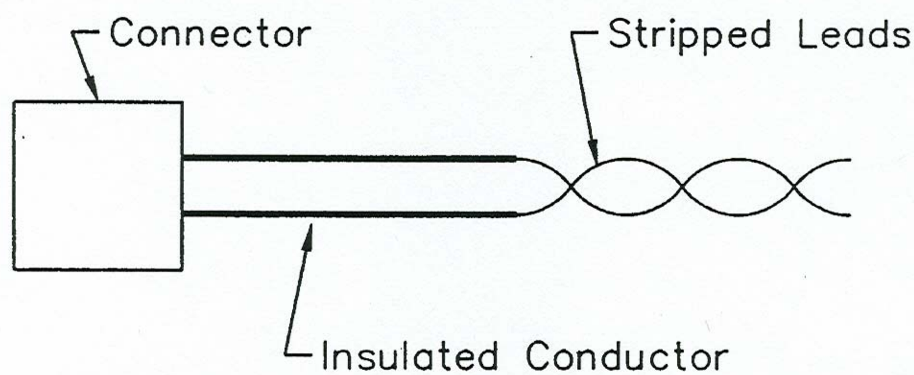
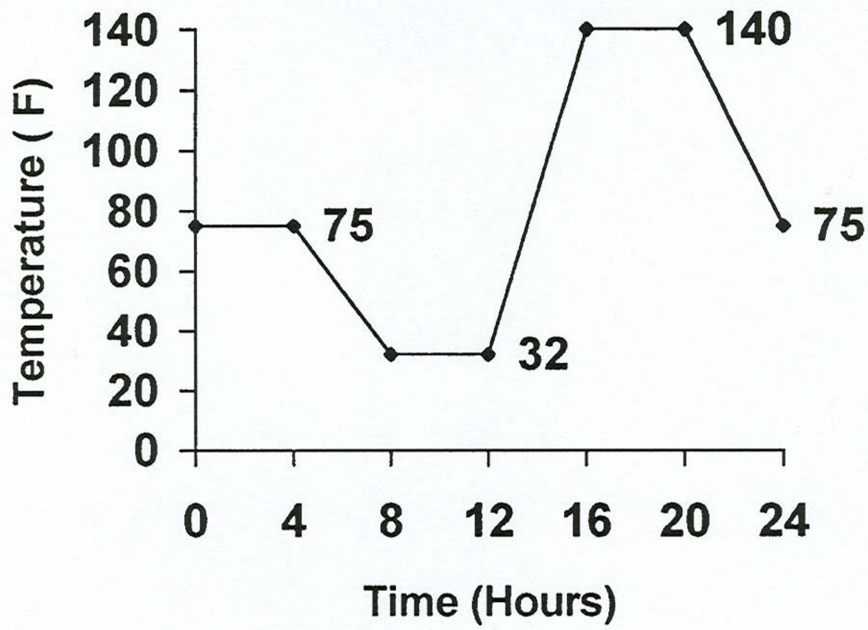


FIGURE 5
TEMPERATURE CYCLE – HUMIDITY TEST



Note: Relative Humidity = 95% +/- 3%

FIBURE 6
TEST SETUP CURRENT CYCLE TEST

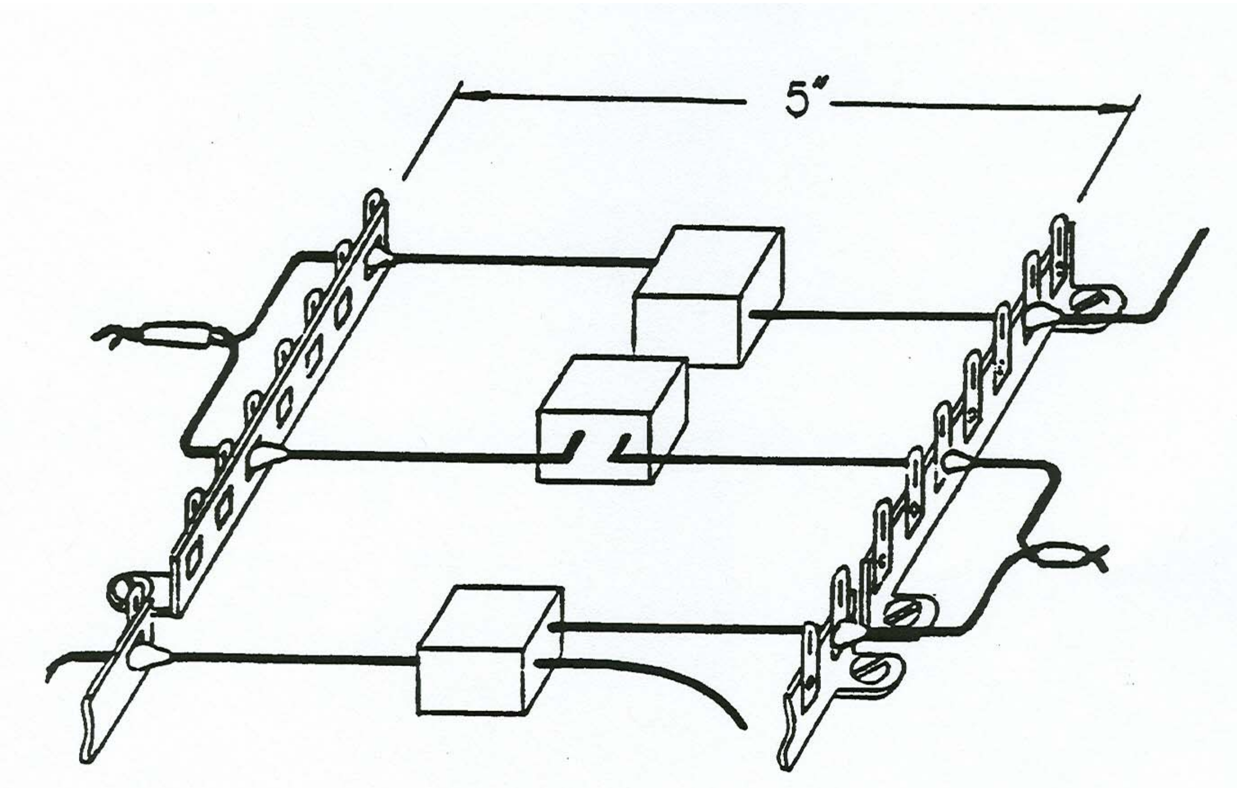


FIGURE 7
TEST SETUP – TENSILE STRENGTH TEST